

# Technical and Innovation Update

11 May 2021

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## Host



**Tony O'Neill**

Group Technical Director

## Speakers



**Matt Daley**

Group Head of Mining



**Dave Palmer**

Group Head of Business Improvement



**Rohan Davidson**

Group Chief Information Officer



**Arun Narayanan**

Group Chief Data Officer



**Donovan Waller**

Group Head of Technology Development



**Pierre Herben**

Group Head of Carbon Neutrality

# Re-imagine mining to improve people's lives





# A new trajectory for mining

## **Operational Excellence**

Full potential

Stability

## **Digitalisation through VOXEL™**

## **FutureSmart Mining™ Technologies**

Bulk ore sorting

Coarse particle recovery

Hydraulic dry stacking

Microwave

Hydrogen trucks

## **Carbon Neutrality Energy Strategy**

The challenge

The pathways

Progress

## **Full Value**

Portfolio

Partnerships

Society

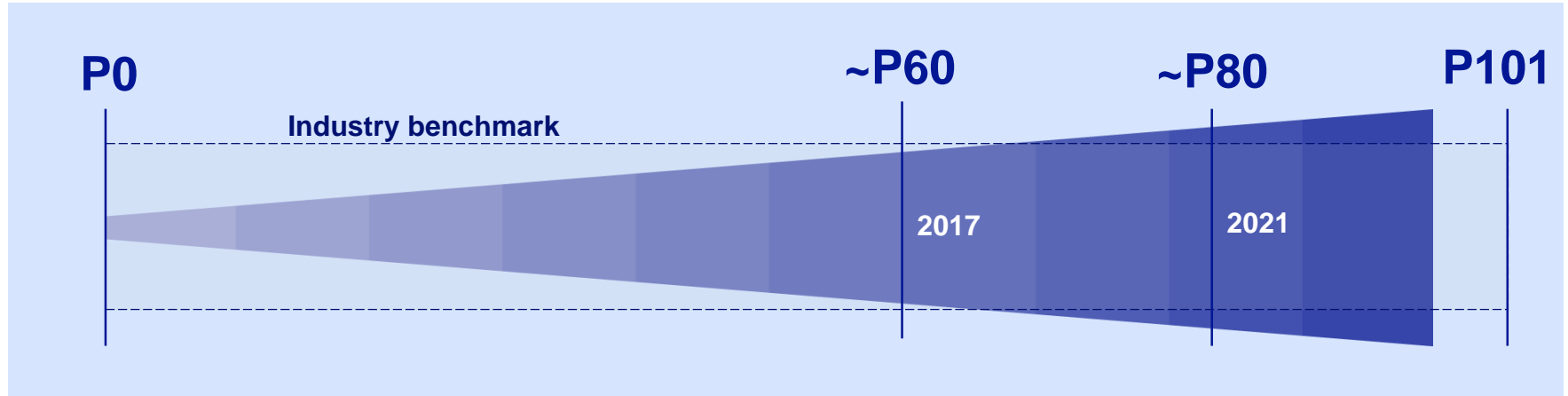


# Delivering our full potential through P101

## What is P101?

- P101 is our breakthrough productivity programme
- Initiatives are focused on delivering industry leading performance and productivity across all our key plant and equipment
- Ensure integration across all processes and focused on value delivery

## Operational Excellence





# Delivering our full potential through P101: Mining

## P101 Tactical Mine Design

- Planning the mine around the equipment
- Enabling high plan compliance
- Further incorporating safety in design
- Key contributor to delivering >25% improvement in shovel productivity

### Before



### After



# Delivering our full potential through P101: Mining

## Blasting Design

- Fragmentation models enabling fit-for-purpose designs
  - Improved fragmentation delivering improved truck and shovel payloads and milling rates
- Eliminated unproductive trim / buffer blasts
  - 20-50% reduction in number of weekly blasts
  - ~50% improved shovel loading rates in trim blast areas

## Blasting Practices

- 50% improvement in drill and blast execution vs plan
- Enabled via real-time, in-field digital platforms
- Delivering improved safety and social performance





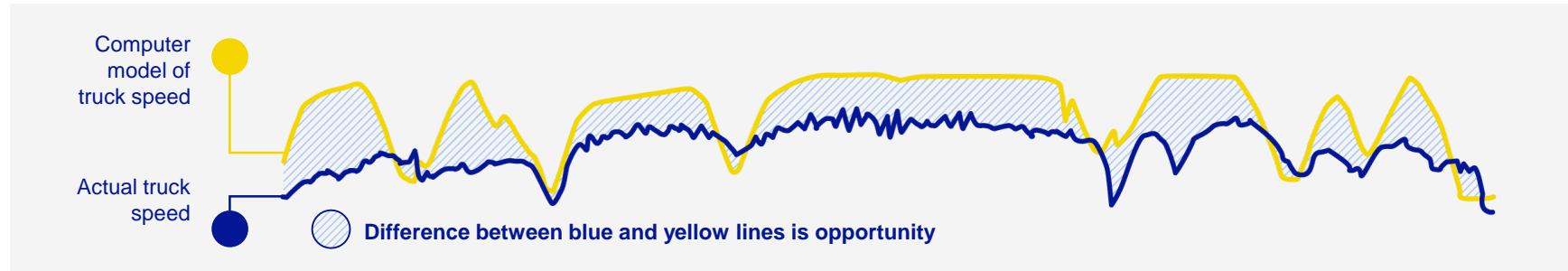
# Delivering our full potential through P101: Mining

## Haul Road Digital Twins

- Analyse and improve existing haul roads
  - Mogalakwena – 23% reduction in haul cycle time; 40% improvement in truck average empty speeds on main haul cycle
- Locking in benefits during design phase of future haul roads



## Computer Model vs Truck Speed



# Delivering our full potential through P101: Processing

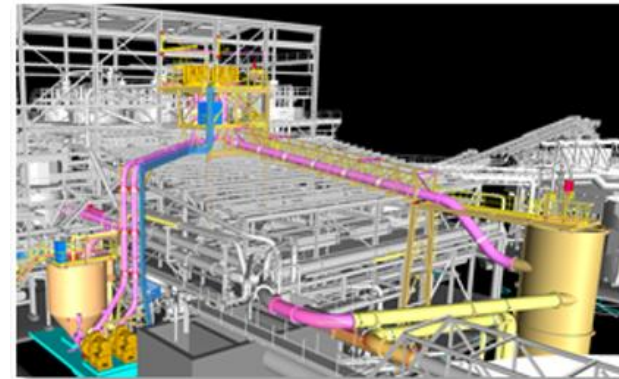
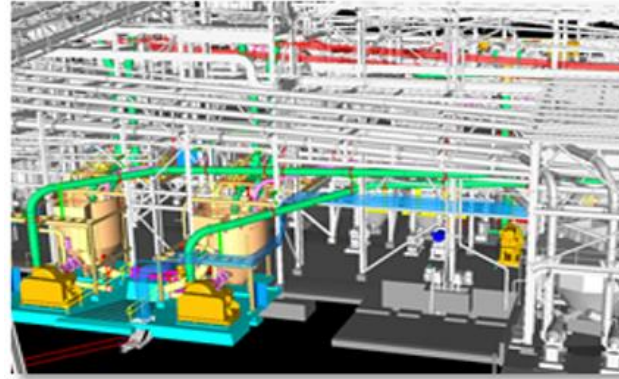
## Maximising Processing Value Drivers

### Throughput

- Systematic debottlenecking through dynamic modelling enabled targeted process design upgrades
- Circuit reconfiguration to achieve increased process efficiency utilising existing infrastructure
  - 7% year on year increase in Minas Rio throughput rate

### Run Time

- Remote asset monitoring to anticipate maintenance and model optimum shutdown strategy
- Implementation of asset tactics, spares management and improved material handling – reduced blockages and improved plant stability and runtime
  - 12% increase in weekly Direct Operating Hours at the Moranbah Complex Coal Plant



# Delivering our full potential through P101: Processing

## Maximising Processing Value Drivers

### Recovery

- Geometallurgical modelling tailoring operating parameters to mined material
- Circuit reconfiguration, reagent optimisation, and operating parameter adjustment
  - 2% increase in Minas Rio mass recovery

### Revenue

- Optimising ore blends tailors product to customer's value-in-use
- Defining Drill and Blast requirements, optimising crusher settings and screen configurations to preserve and maximise Lump
  - 5% improvement in Kumba lump:fine ratio



# Delivering our full potential through P101

## P101 Best Practice Principles

- Locking in the improvements
- Building a foundation to redefine the benchmark
- Positioned for future autonomy / technology deployment





# Delivering our full potential through P101

**+16%**

Truck  
Utilisation  
**Orapa**

**+5%**

Truck  
Payload  
**Los  
Bronces**

**+25%**

Rope Shovel  
Volume  
**Mogalakwena**

**+9%**

Beneficiation  
Rate  
**Minas-Rio**

**+5%**

Concentrator  
Runtime  
**Mogalakwena**

**+5%**

Lump:Fine  
Ratio  
**Kumba**

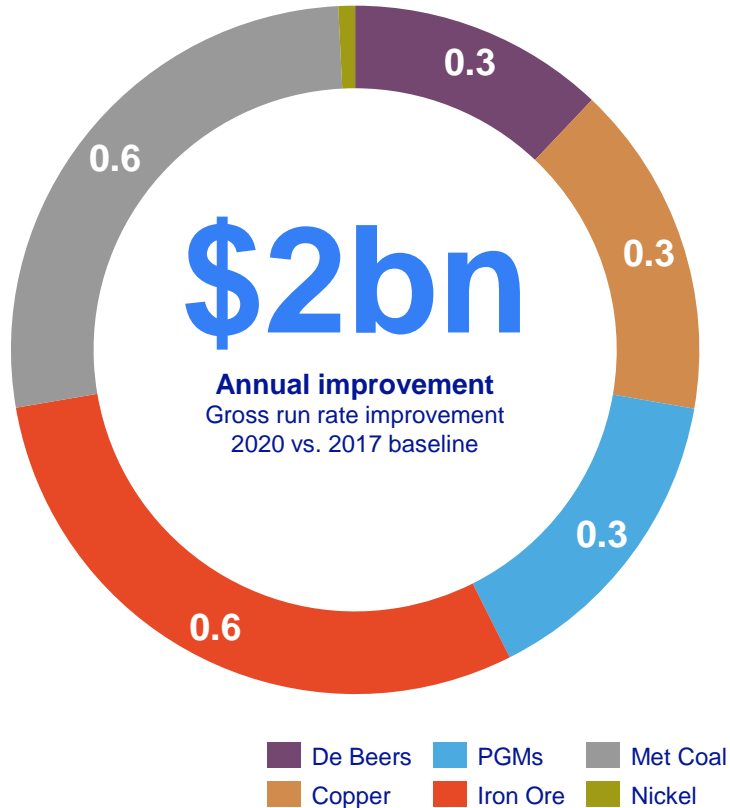
**+30%**

CHPP  
Throughput  
**Moranbah**

De Beers PGMs Met Coal  
Copper Iron Ore Nickel



# Tangible value delivered

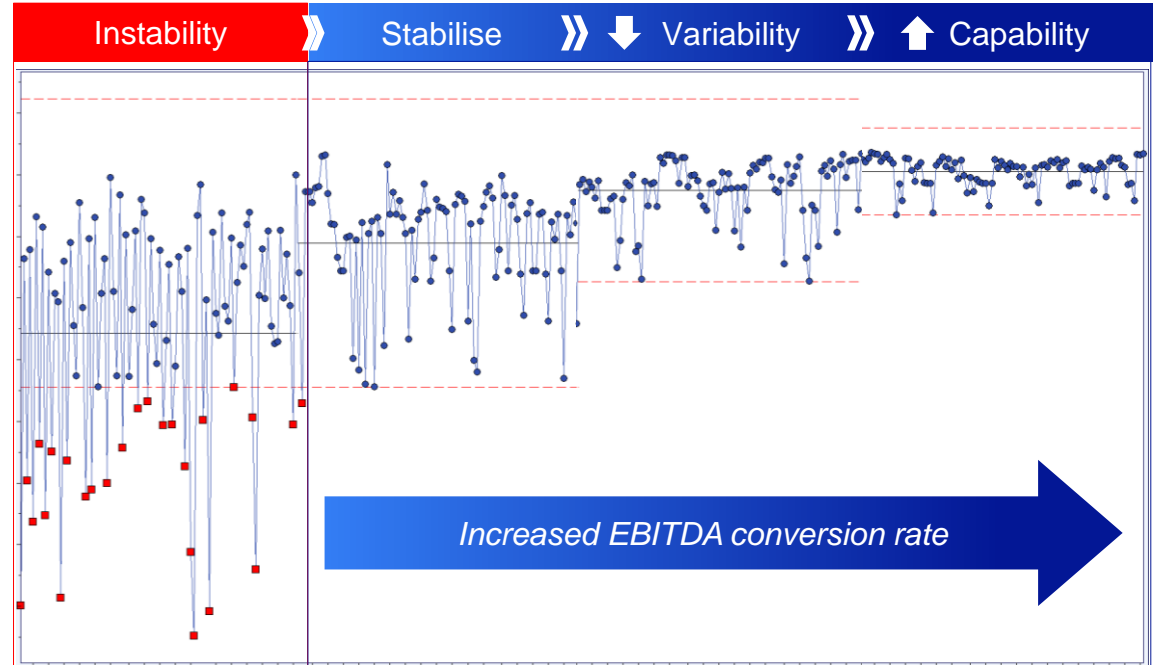
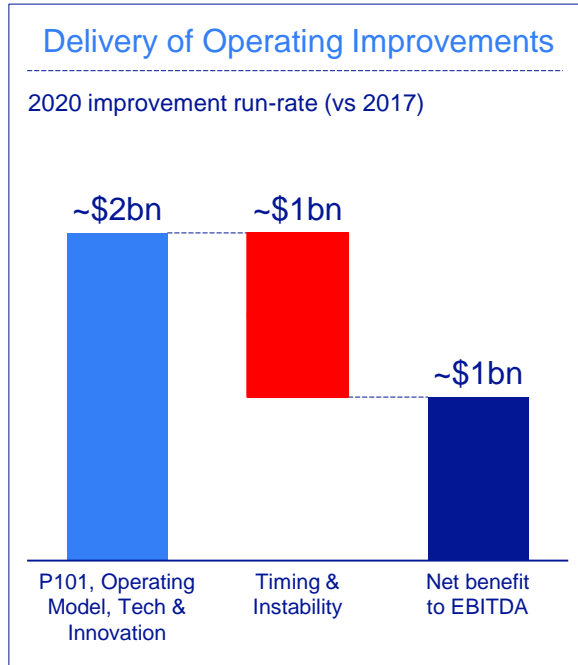




# Stability is the key to sustaining our full potential



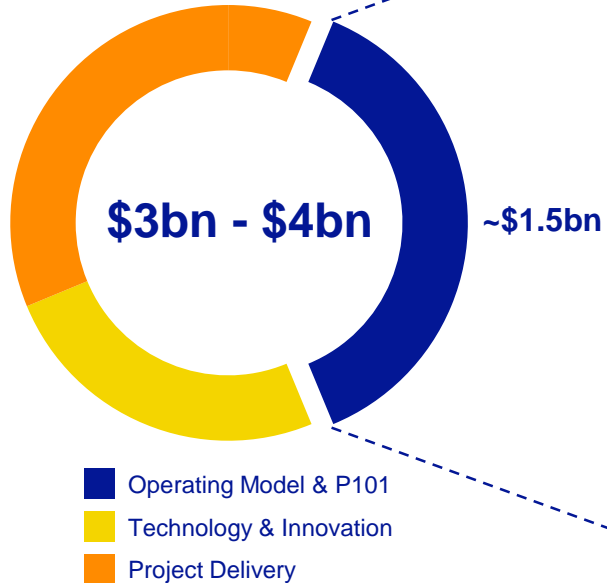
# Stability is the key to sustaining our full potential



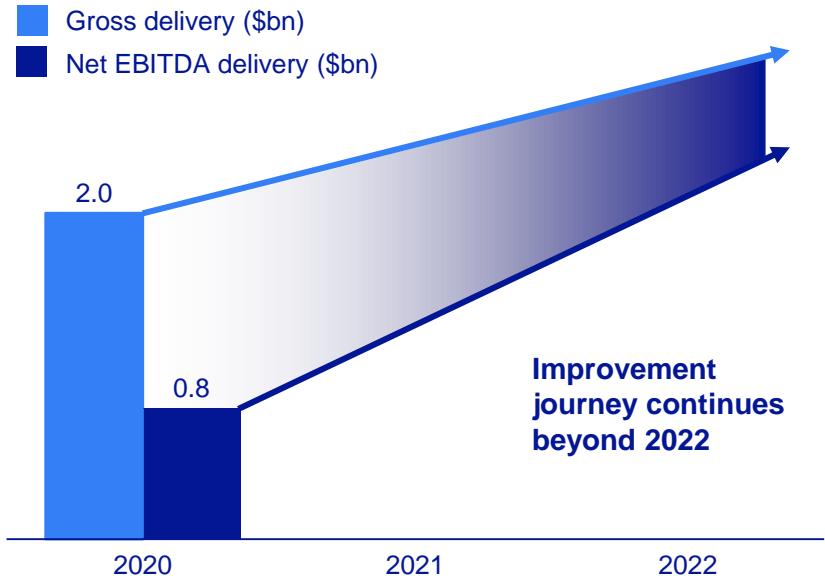


# Stability delivers EBITDA

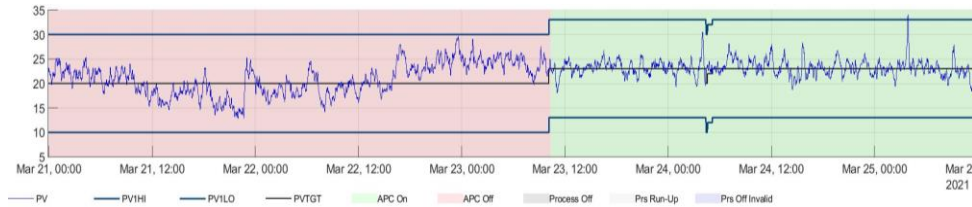
2017-2022 EBITDA  
Improvement Commitment (\$bn)



Anglo American Operating Model & P101 Delivery – On track

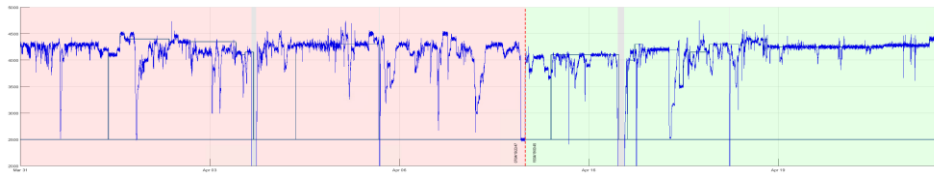


# Advanced Process Control automates stability of plant process



48%

Minas-Rio: 48% increased stability in float circuit, lifting throughput by 4%



32%

Los Bronces: SAG mill throughput maintained at 32% greater stability



17%

17% reduction in energy per tonne milled

# APC improves energy and water efficiency

## Sustainability benefits include

- 4% reduction in water consumption at Los Bronces grinding mills
- 4-12% energy reductions from APCs controlling SAG mills
- 80% reduction in plant micro-stoppages from plant-wide optimisers in South Africa and Brazil
- Minimised product loss and improved water efficiency from fibre optic sensor wraps that surround piping to dynamically model the flow of metal in process
- Reduction in maintenance of high-value moving parts including motors, pumps, conveyor belts

**14ktCO<sub>2e</sub>**  
Carbon reduction

**173kJ**  
Energy savings

**\$5m**  
Energy cost savings

# APC improves energy and water efficiency



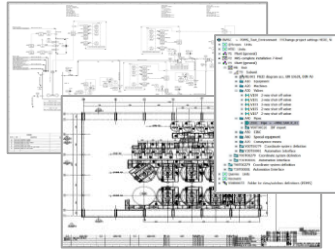
Large scale 3D scanning



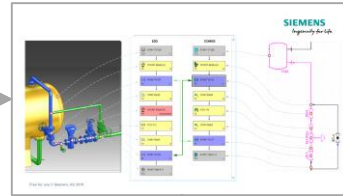
3D point cloud extraction from scan



2D diagrams / drawings & equipment data base



Digital Twin



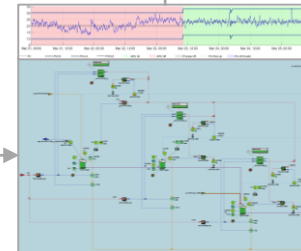
Virtual asset:

- Virtual plant walks
- Access to equipment data / specs
- Live process data feed
- Live video feed



Live APC data

APC plant model

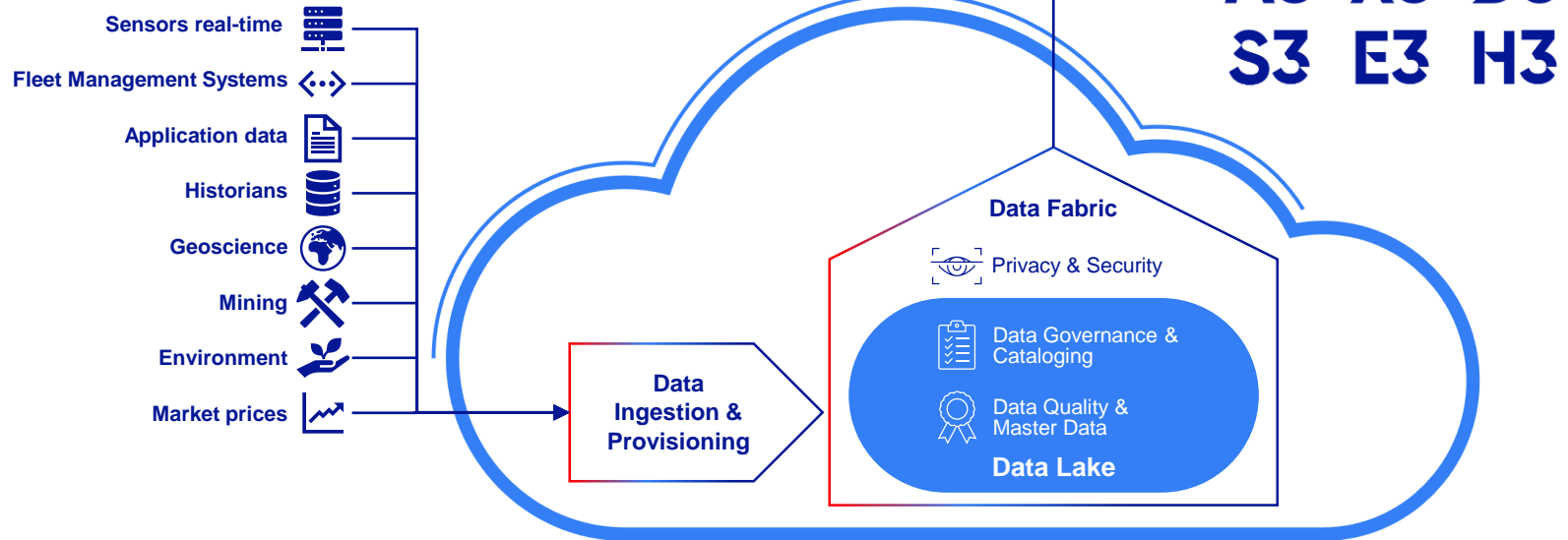


High performance plant scale computer aided design modelling





Industry-first digital transformation  
platform for data-driven decisions



# VOXEL is different



Built for mining

Spans full value chain

Leverages technical and sustainability knowledge

Digital twins of the entire value chain

VS

## Others

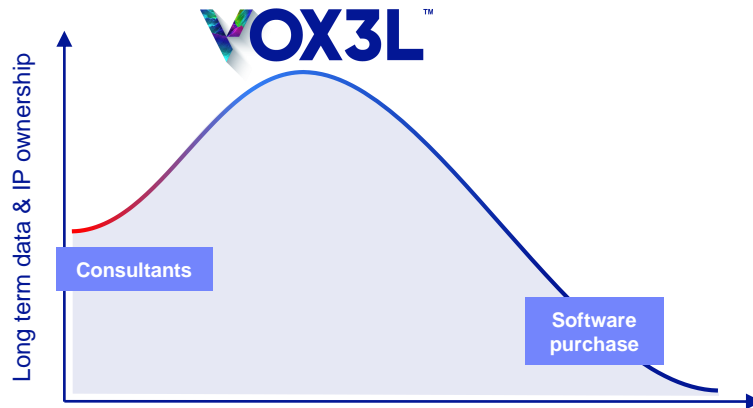
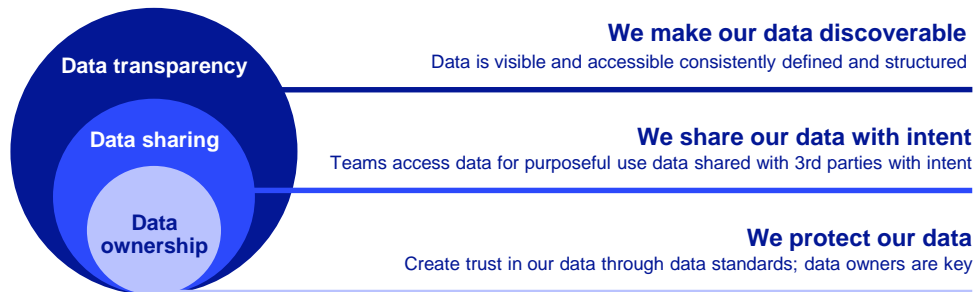
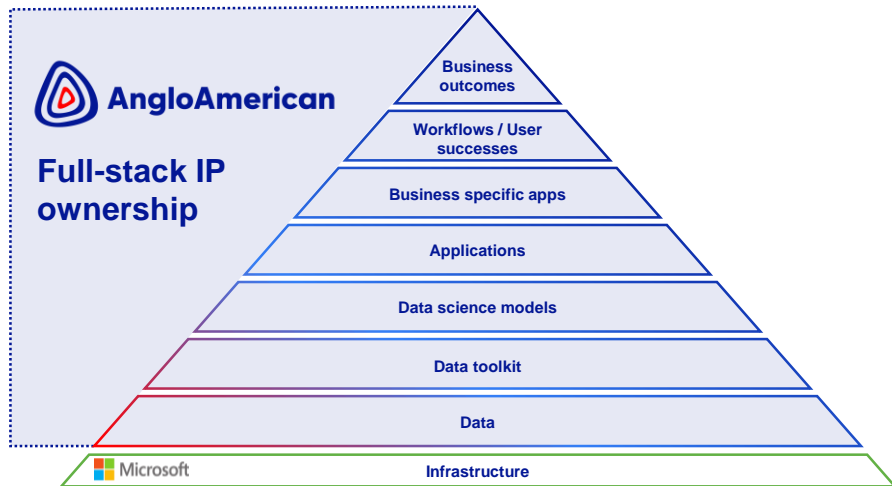
Built for equipment

Focused on equipment health

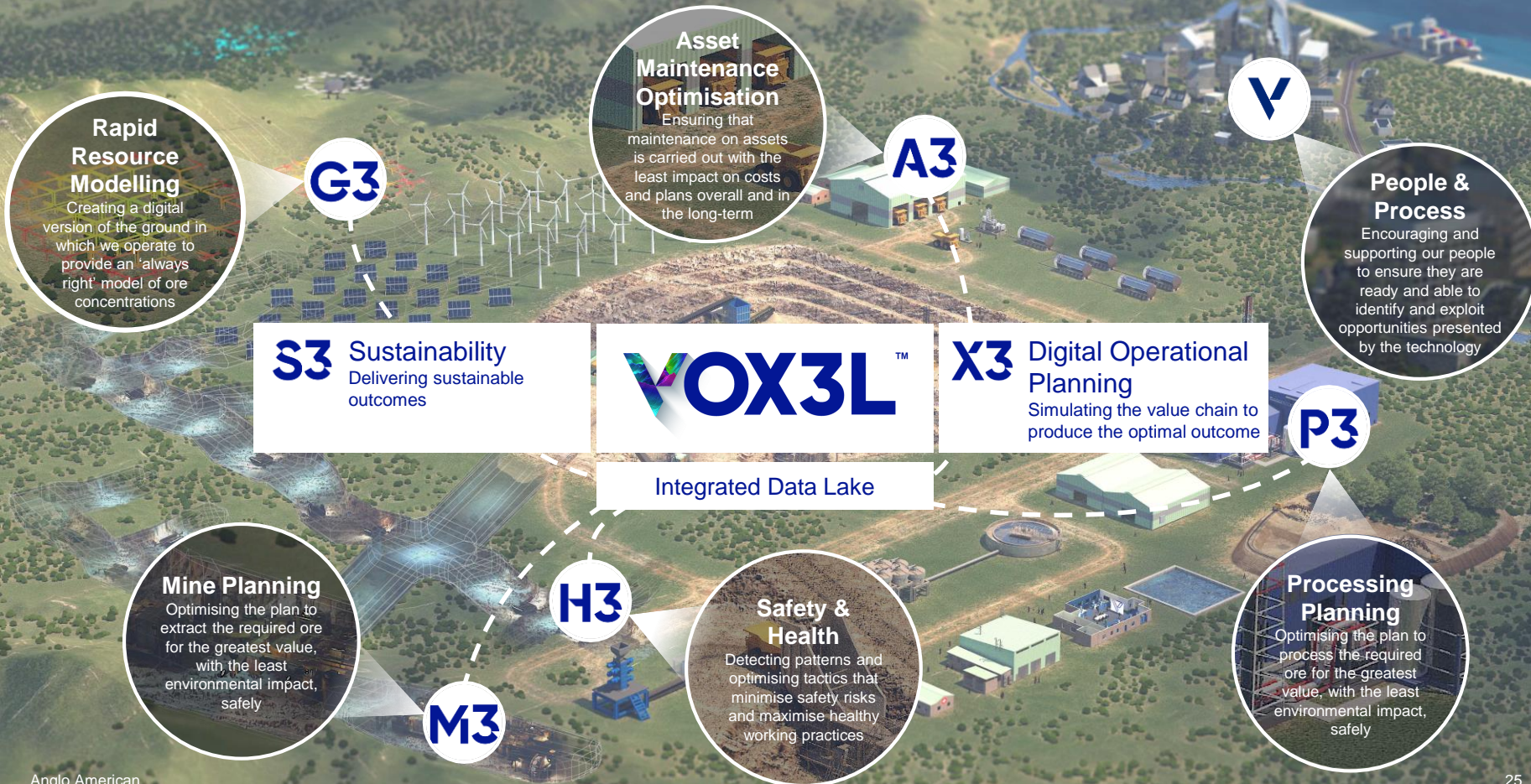
Leverages other industry knowledge

Digital twin of one asset

# VOXEL drives intellectual property and data ownership







### Rapid Resource Modelling

Creating a digital version of the ground in which we operate to provide an 'always right' model of ore concentrations

**G3**

### Asset Maintenance Optimisation

Ensuring that maintenance on assets is carried out with the least impact on costs and plans overall and in the long-term

**A3**

**S3** Sustainability  
Delivering sustainable outcomes

**VOX3L™**

**X3** Digital Operational Planning  
Simulating the value chain to produce the optimal outcome

### People & Process

Encouraging and supporting our people to ensure they are ready and able to identify and exploit opportunities presented by the technology

**V**

**P3**

### Mine Planning

Optimising the plan to extract the required ore for the greatest value, with the least environmental impact, safely

**M3**

### Safety & Health

Detecting patterns and optimising tactics that minimise safety risks and maximise healthy working practices

**H3**

### Processing Planning

Optimising the plan to process the required ore for the greatest value, with the least environmental impact, safely

Integrated Data Lake

# Processing Optimisation

P3

Process Health – Mogalakwena North (PGM concentrator)

## Before

- Comparing current performance against its historical statistical mean, which had moving bottlenecks that led to process instability

## Challenges detecting bottlenecks



## After

- P3 points out process deviations seamlessly
- Metallurgist can investigate and solve the process anomaly quickly
- Auto-detect the context of the plant
- Coming soon: Recipe optimization with Greenhouse Gas modelling

## Quickly detecting anomalies and bringing stability into process



# Asset Management

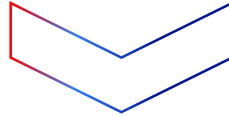
# A3

Predictive maintenance – ACP (PGM processing)

## Before

- Traditional approach is reactive
- Breakdown of assets resulted in production impact
- Unplanned stoppages

## Under/over maintenance



## After

- Proactive continuous monitoring with early prediction of anomalies
- Sufficient time to plan and act for the maintenance resolutions
- Impact to whole plant avoided, as anomalies are detected at the right time

**5 catches that helped  
to protect 121 hours  
of downtime**



# Safety and Health

# H3

## COVID-19 response

### Purpose

- Understand COVID-19 levels across Anglo American
- Identify people recently exposed
- Enable testing

### Potential infection risks



### Outcomes

- Dashboards deployed
- Proven accurate case identification
- Benefits to employees and to the company

### Identified without undue disruption to life and work





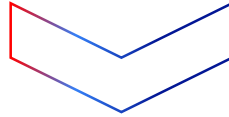
# Sustainable Operations

## Greenhouse Gas modelling

### Purpose

- Provide a sustainability lens view across the mining value chain

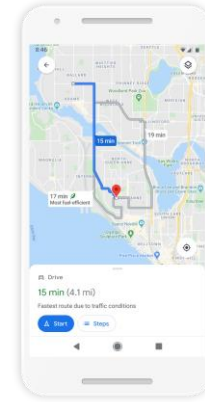
**GHG emissions  
not impacting  
plans**



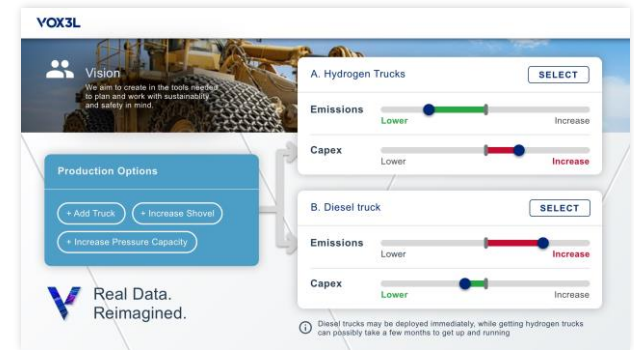
### Outcomes

- Simulate and provide optimal environmental recommendations based on integrated value generated across the mining value chain

**Capability to balance  
planned throughput  
with expected  
emissions**



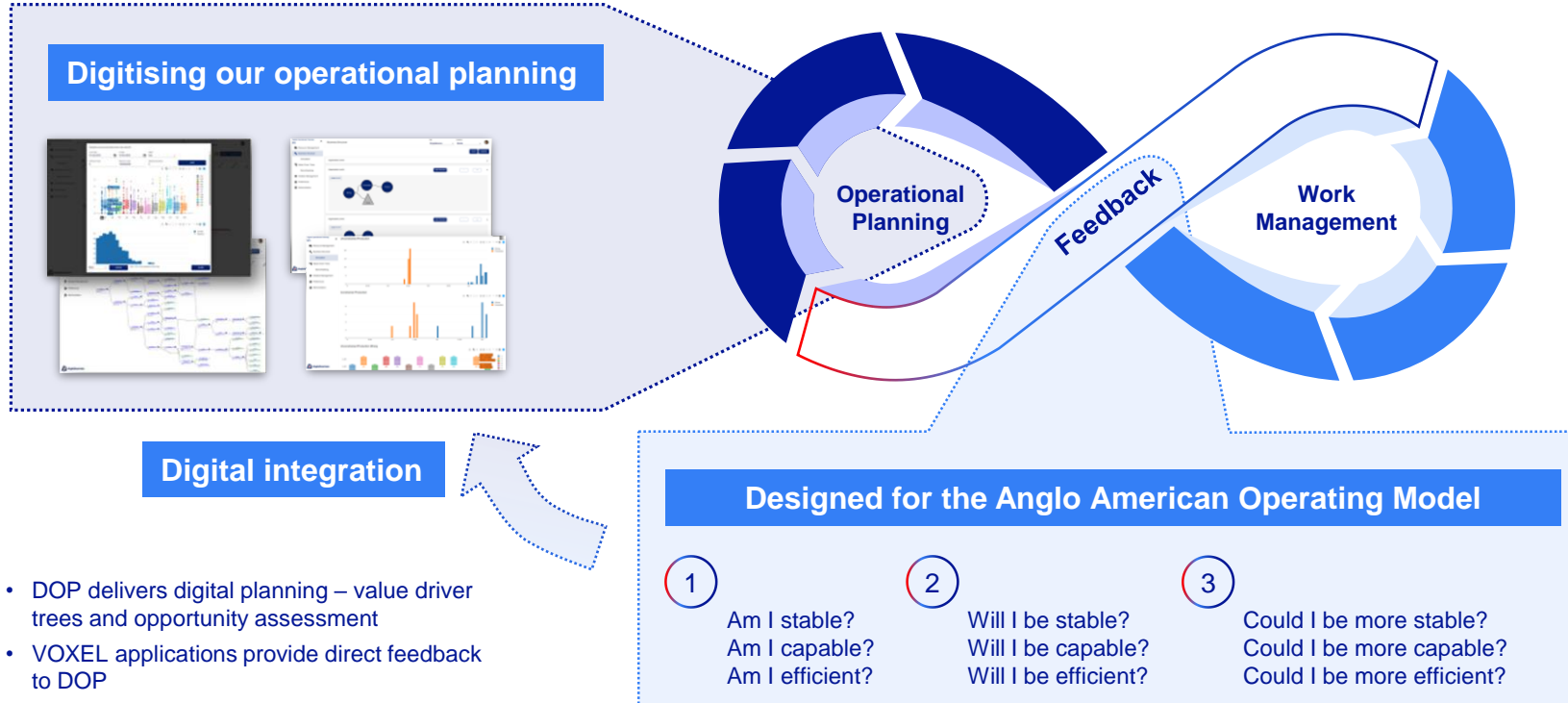
**S3**





# Digital Operational Planning

X3



# Digital literacy is a key enabler

## Building a digitally literate organisation



### Data and digital foundations

- Training for all employees to drive a better understanding of data and digital concepts
- Underpins the evolution of a data and digitally-enabled culture



### Data analytics nano-degrees

- Developing and applying deeper skills to apply data, analytics and digital principles across the organisation
- Data citizen programme, to augment technical/SME skills with analytics capabilities

### Data / Digital Literacy & Nano-degrees



### Progress

Percentage of eligible people who have completed one or more training module

PGMs	40%	<div></div>
Base Metals	11%	<div></div>
Bulks	24%	<div></div>
De Beers	52%*	<div></div>

\* Currently in a pilot user group

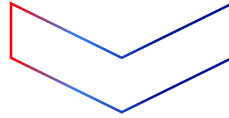
# VOXEL enables remote work

Integrated Remote Operating Centre (IROC)

## Before

- Effort and risks of travel to mining sites
- Data sourced from multiple, separated systems
- Limited access to experts

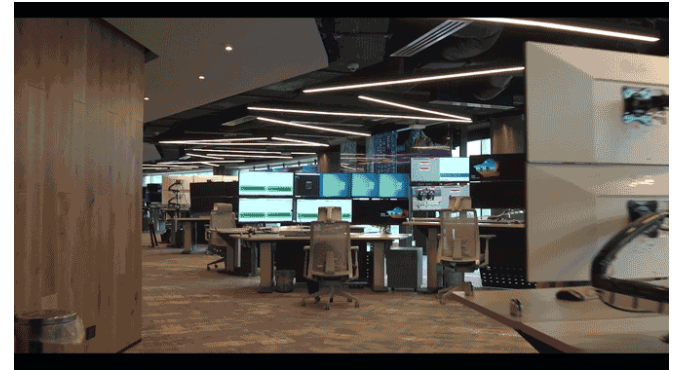
**In-person, on-site  
working**



## After

- New way of working
- Integrated data sets and expert access
- Remote control room for Los Bronces in Q1 2021

**Digitally-enabled  
specialists, working  
remotely**

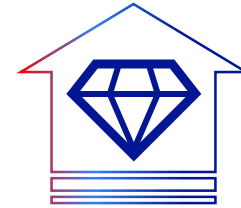




**Sustainability  
Efficiencies**



**Digital Transformation**



**Value Growth**

**Technology**

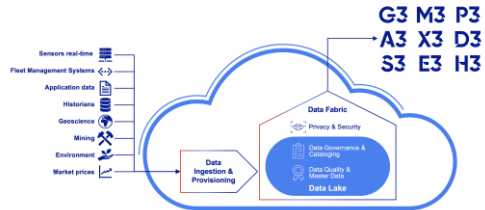
Technology  
provides the tools

**People**

Training and  
support provides  
the skills

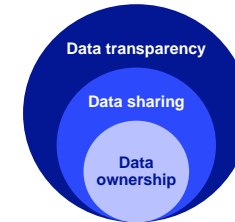
**Process**

Processes provide the infrastructure that  
empowers a new way of working



Data & Digital Foundations

Data Analytics Nanodegrees



**IROC**

# FutureSmart Mining™ integrates technology & sustainability





# Concentrating the Mine™: Bulk ore sorting

## Overview

- Early rejection of waste increases plant grades and metal output

## Key benefits example – Mogalakwena

- Reduces energy and water intensity
- Mass reject 5% - 20%
- Delivery in 2021

## Rollouts

- Barro Alto 2021/2022
- Los Bronces 2021-2023
- Other sites are under study



# Concentrating the Mine™: Coarse particle recovery

## Overview

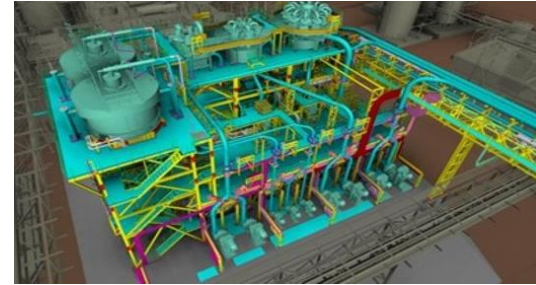
- Increased throughput by recovering metal at larger particle sizes
- An enabler for hydraulic dry stacking

## Key benefits example – Quellaveco

- 10-20% less energy and wet tailings
- Up to 85% water recovery with hydraulic dry stack
- Up to 4% production increase through tailings retreatment
- Additional ~12-35% production through full expansion

## Rollouts

- Los Bronces 2023
- Minas-Rio 2023
- Investigating options at Collahuasi



# Concentrating the Mine™: Hydraulic dry stacking

## Overview

- Low cost, safe, geotechnically stable dry tailings

## Key benefits

- Eliminate risk of liquefaction
- Increased water recovery ~ 85%
- Can be repurposed, benefiting host communities and biodiversity

## Rollouts

- El Soldado demonstration 2021
- Together with CPR, potential for 20-30% additional production at Collahuasi and Quellaveco within existing water licences



# Hydrogen truck and plant

## Mogalakwena update

- Hydrogen plant and solar PV ready at Mogalakwena Q4 2021
- Scale up to 2024, with expected electrolyser capacity above 100 megawatts

## Key benefits

- Potential to eliminate 46% of diesel related GHG emissions equivalent to 1MtCO<sub>2</sub>e pa
- Enables new local economies and job opportunities

## Rollouts

- 7 sites expected to have renewable power and hydrogen by 2030



# Concentrating the Mine™: Microwave

## Overview

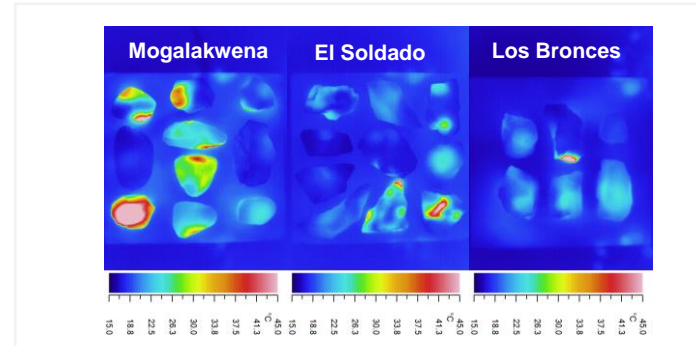
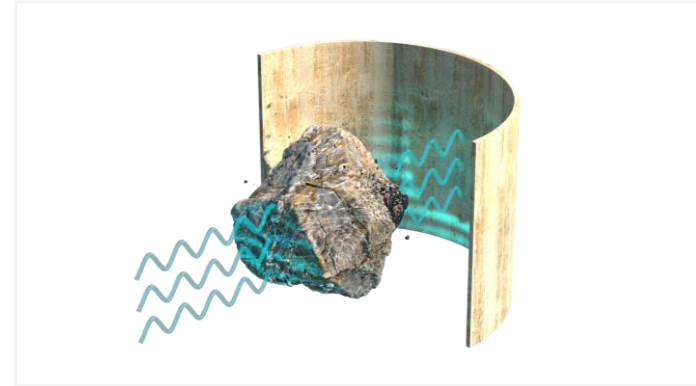
- Use microwave energy to precondition ores, increasing throughput and recovery

## Key benefits

- Reduces energy and water intensity
- Hardness reduction in ores, Pt 5%-25%, Cu 8%-12%

## Rollouts

- Los Bronces, Mogalakwena, Collahuasi and Quellaveco
- Further implementation capex ~\$0.4bn - \$0.7bn



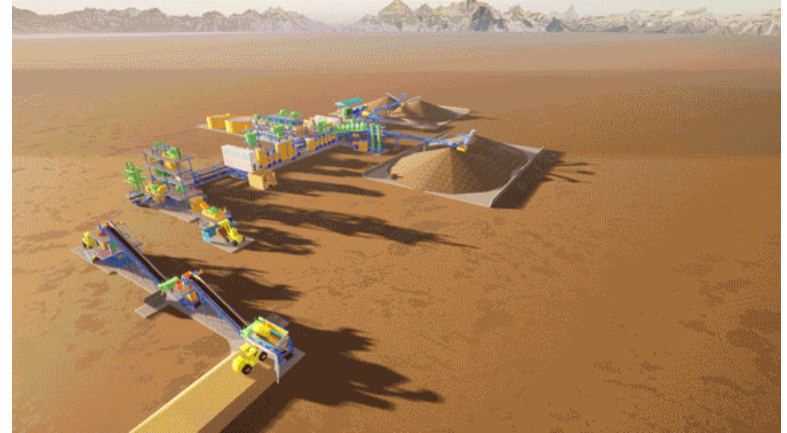
# Speed of innovation to value

## Accelerators of value

- Accelerated development methods
- Risk managed approach
- Agile deployment methods compress rollout time
- Modular concepts
- Implement and improve, using Anglo American Operating Model and P101

## Benefits

- Time to value reduced from 15-20 to 2-5 years

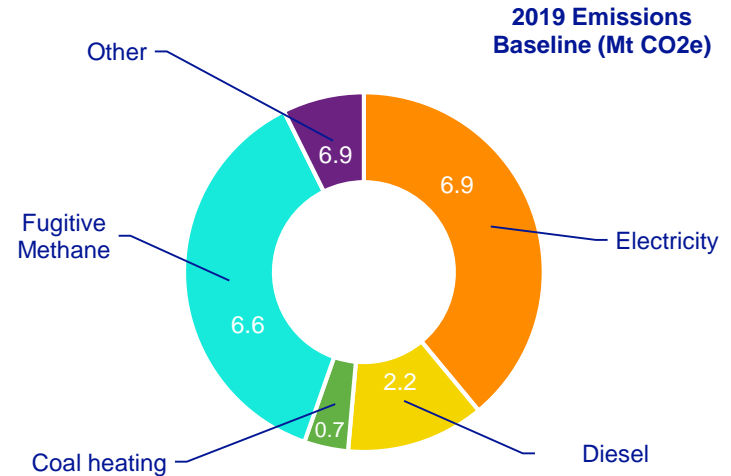
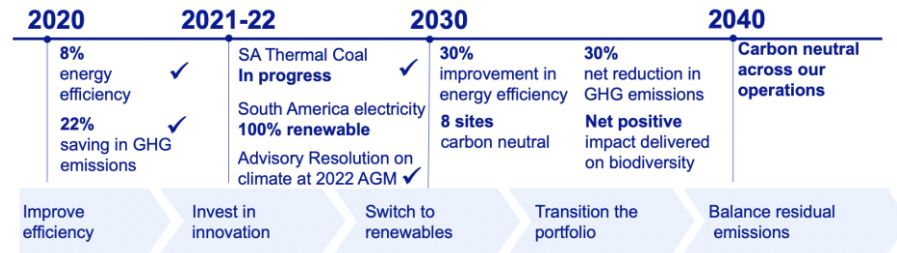




# The carbon neutrality challenge offers a new mining landscape

## Overview

- Strong, market-leading carbon neutrality agenda announced in 2020
- 3 main sources of GHG emissions provides focused effort
- Innovations, technical solutions and viability analysed



# A multi-faceted pathway to carbon neutrality

Our carbon neutrality strategy focuses on 6 levers which, when connected, provide the architecture for a zero carbon future



## 1 Renewable energy generation

Developing a supply of renewable power generation to deliver reliable carbon free electricity



## 4 Methane capture

Leveraging developing technologies to substantially abate vent-air methane, and enhance the safety of our operations



## 2 Hydrogen generation

Developing an integrated green hydrogen production and enabling fuel switching from diesel



## 5 Energy efficiency

Improvements in operational efficiency are significantly decreasing carbon emissions and costs and will continue into our future



## 3 Energy storage

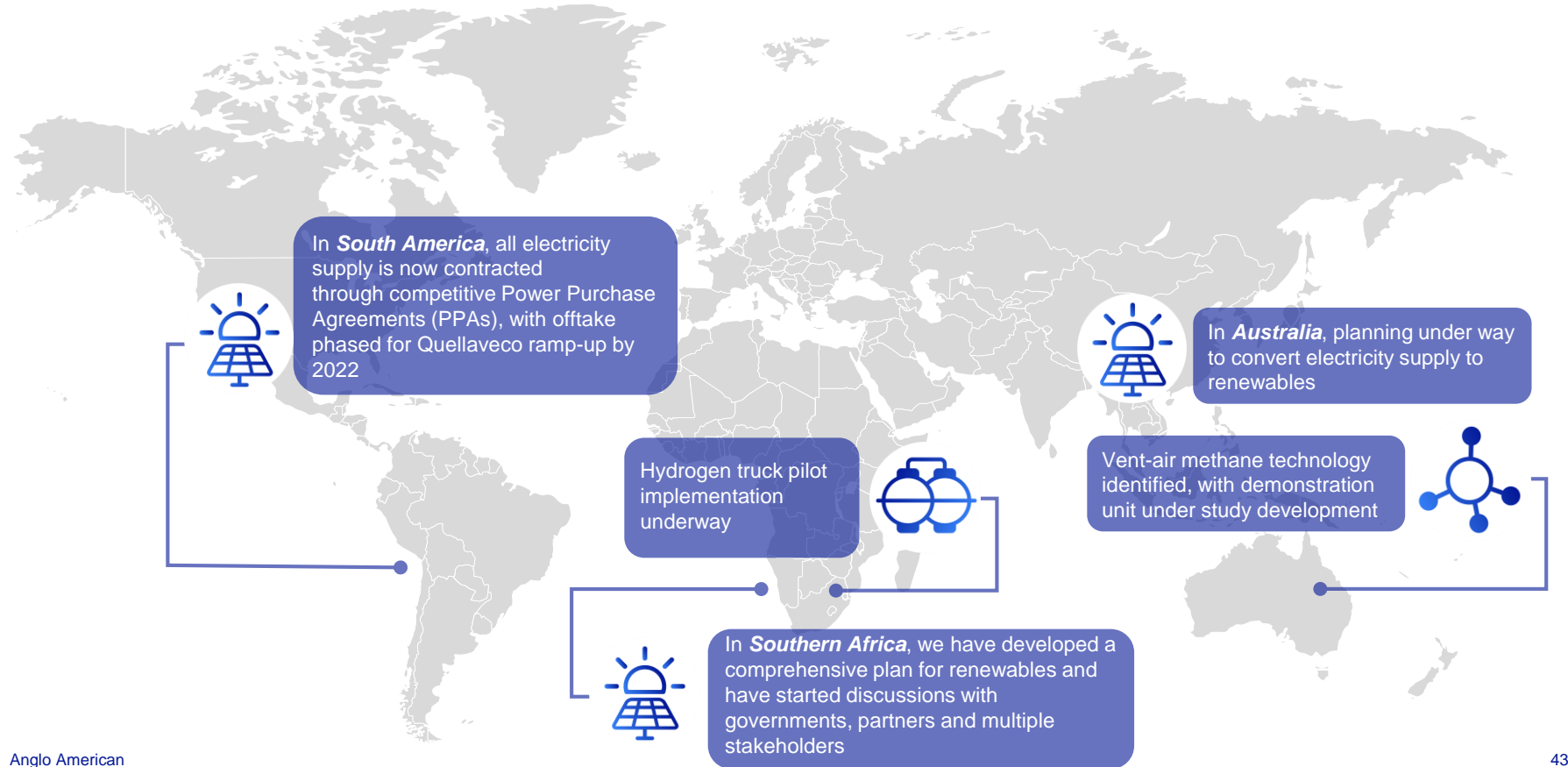
Attractive options to enable 24/7 access to renewable generation and stability are arising



## 6 Emissions compensation

For the remaining hard-to-eliminate emissions, we are developing a pipeline of technology and nature-based CO<sub>2</sub> sequestration and inset solutions

# Initial progress is on track for critical emissions areas

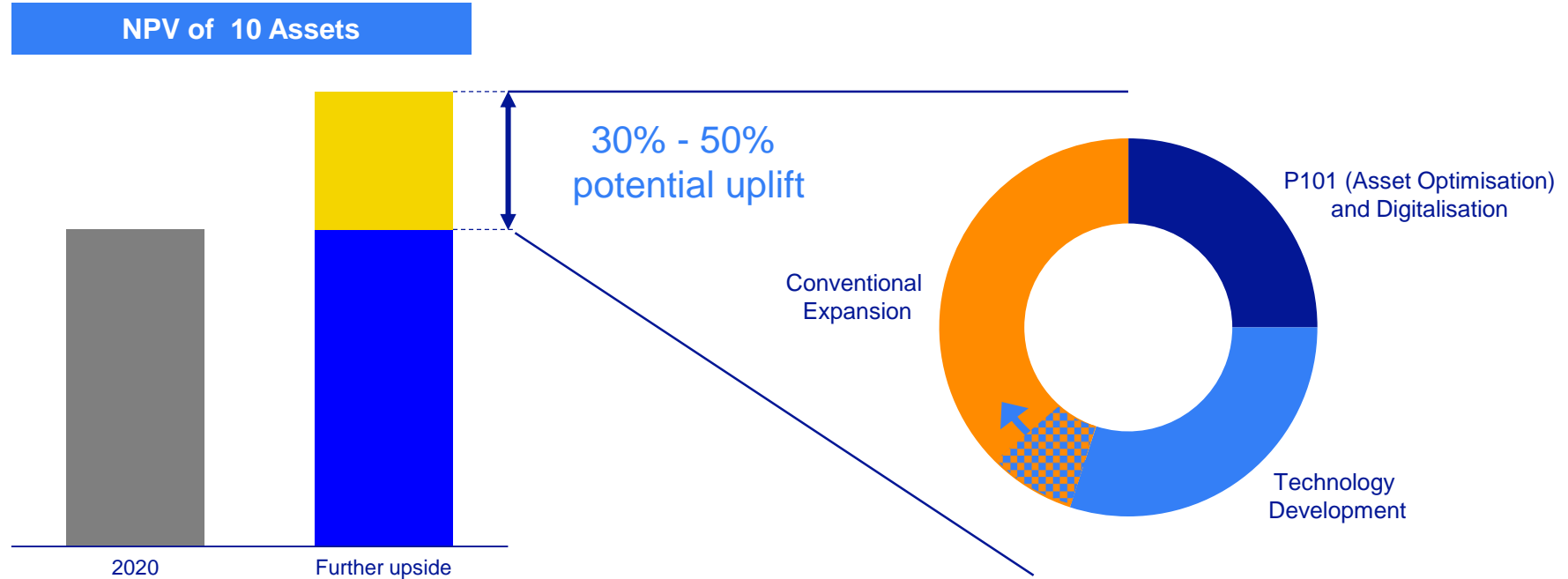




# Technical innovation unlocks optionality



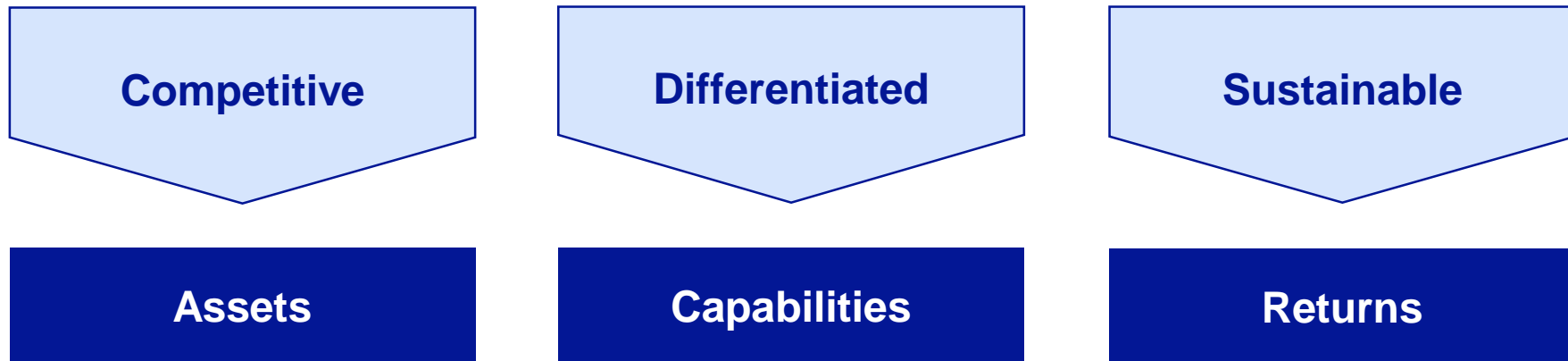
# An integrated view of value for the Group





# Q&A

Our investment proposition...



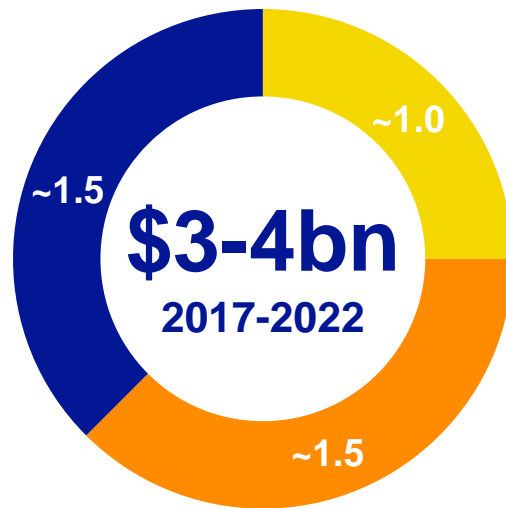
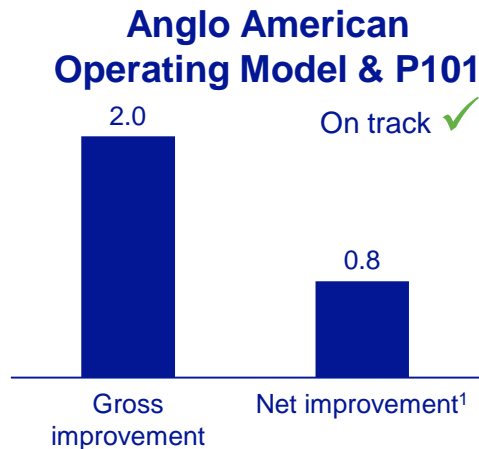
*“Leading capabilities actively improving a competitive, world-class asset base to drive sustainable, attractive returns”*

To ask a question, please dial: UK +44 (0) 2071 928338 / SA 0800 014552 / US 1 87787 09135  
Conference ID: 5882825

Thank you

# Appendix

# Progress on 2017-2022 EBITDA improvement target

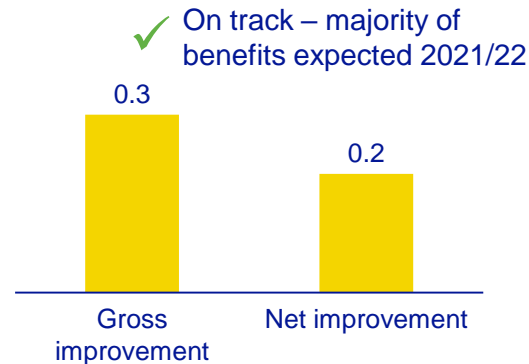


## Project delivery

Quellaveco (Copper) &  
Namibia vessel (Diamonds)

Both 2022 and on track ✓

## Technology & Innovation



1. Improvement in EBITDA also impacted by above-CPI cost inflation of \$0.2bn (2018-2020)